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Veneras: First Entry Probes Trajectory Reconstruction and Science

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Of the 33 probes launched since 1961 to enter the atmospheres of other planets 20 were Soviet - 16 to Venus and 4 to Mars. With except of the first three all thirteen other Venera probes entered and operated successfully in the Venus atmosphere while signal and some data were received from only two Mars probes. The first generation of Venera probes (Venera 4 - Venera 8) had a simple entry vehicle with small number of science instruments (4-6) and very low data rate (1 bit/s). The main goal was to get the very basic knowledge about the planet and narrow the highly broad range of the Venus environment uncertainties. The robust entry vehicles survived ballistic entries with accelerations up to 300-400 g. Two of the probes landed on the surface and operated for 1 and 1.5 hrs.

The trajectory reconstruction of Venera 4 produced a major confusion at that time when concluded that the Venus surface pressure is ~ 20 atm while the one-way Doppler tracking and trajectory reconstruction of Venera 8 lead to discovery of superrotation of bulk of the Venus atmosphere. At the most dramatic descent of Venera 7 whose parachute was damaged and telemetry transmitted temperature data only, the Doppler tracking and digital data processing helped to reconstruct the trajectory and to save the mission data. Doppler tracking became a must since on all Soviet entry probes.

The second generation of Veneras were launched on the Proton launch vehicle and were much more capable. Spherical entry vehicle contained the lander and in case of VEGA probes - the lander and the balloon. Simultaneous deployment of lander and balloon from the same entry vehicle realized the most complicate even up to-day deployment scheme with multiple parachutes. Combination of parachute and metal "skirt" provided extended duration of the lander descent in the Venus cloud and fast descent to the surface. Engineering and science data were relayed to Earth via orbiter or fly-by at much higher rate. Data on the entry parameters and dynamic behavior during entry and descent are given in more details. Trajectory reconstruction using the Doppler, pressure, temperature and engineering data yielded new wind profiles as well as data on turbulence in the Venus atmosphere.